Responses to SC&A's Review of NIOSH's White Paper, "Neutron Dose Assignment for K-25 and Portsmouth Gaseous Diffusion Plants" (Document No. SCA-TR-2019-SP002, Revision 0)

Response Paper

National Institute for Occupational Safety and Health

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RESPONSE TO SC&A: OBSERVATION 1 – APPARENT INCONSISTENCY IN USE OF LIMIT OF DETECTION

Observation 1: Apparent Inconsistency in use of Limit of Detection (Portsmouth vs. K-25)

> *The use of the neutron dosimetry data and photon data dosimetry data that were equal to the LOD values needs to be clarified; i.e., were equal to values used in NIOSH's analysis, or only values that were greater than the LOD?*

Response

For both the Portsmouth and K-25 analyses, data *greater than or equal to* the limit of detection (LOD) were used; i.e., the approaches were consistent. The text from this White Paper will be revised when this verbiage is added to the Site Profile Technical Basis Documents (TBDs) to make these approaches clear.

While not part of this observation, NIOSH did try to replicate SC&A's calculated neutron-to-photon (N:P) value for Portsmouth (0.412) but was not able to exactly match this result. The difference between the NIOSH (0.369) and SC&A values (0.412) is likely due to the treatment of neutron data starting in 2010, when Portsmouth implemented the International Commission on Radiological Protection (ICRP) Publication 60 neutron weighting factors. The NIOSH value was calculated with a correction implemented to account for the weighting factor change. The approach used by SC&A would need to be seen directly to confirm the reason for this difference.

RESPONSE TO SC&A: OBSERVATION 2 – USE OF PORTSMOUTH DOSIMETRY VALUES NEAR ZERO

Observation 2: Use of Portsmouth Dosimetry Values Near Zero

> *It appears from Figures 2 and 4 of the white paper that recorded data with values as low as near zero might have been used (with the QRA method). This is not consistent with the use of dosimetry that is equal to or greater than the LOD.*

Response

Uncensored neutron dose data and uncensored photon dose data were available for Portsmouth, so they were modeled as is. Modeling of complete data, when available, is always preferable to modeling censored data.

RESPONSE TO SC&A: OBSERVATION 3 – QUANTILE REGRESSION

Observation 3: Use of the Standard N:P Ratios versus the Quantile-Regression and Monte Carlo Approach

> *SC&A concurs with the N:P ratios derived using standard analyses of the dosimetry data for Portsmouth, K-25, and Y-12. However, analyzing the QRA method recommended in the conclusions (page 16) of the white paper indicates that the resulting neutron doses assigned at the 50th percentile in IREP for dose reconstruction purposes would be approximately half of that assigned by the standard N:P averaged ratio method. The QRA method is not claimant favorable, nor consistent with neutron dose assignments at other U.S. Department of Energy sites.*

Response

Quantile regression analysis (QRA) is an established methodology available for use in the project (see ORAUT-RPRT-0087). QRA is the preferred methodology for assigning neutron dose based on photon measurements, and the example below demonstrates why one method is superior to another.

Example: N:P Ratio versus Quantile Regression

Figure 1 shows the plot of photon dose versus neutron dose at Portsmouth. The 50th percentile line resulting from a fit of a lognormal model to the ordered N:P ratios (dashed red line) and the 50th percentile line (solid red line) using the QRA method are presented on the plot. By inspection, it is obvious that the median line based on the N:P ratios increasingly overestimates neutron doses as the photon dose increases. For example, the neutron dose estimated from a 0.04 rem photon dose is 0.024 rem, three times larger than the result obtained by quantile regression.

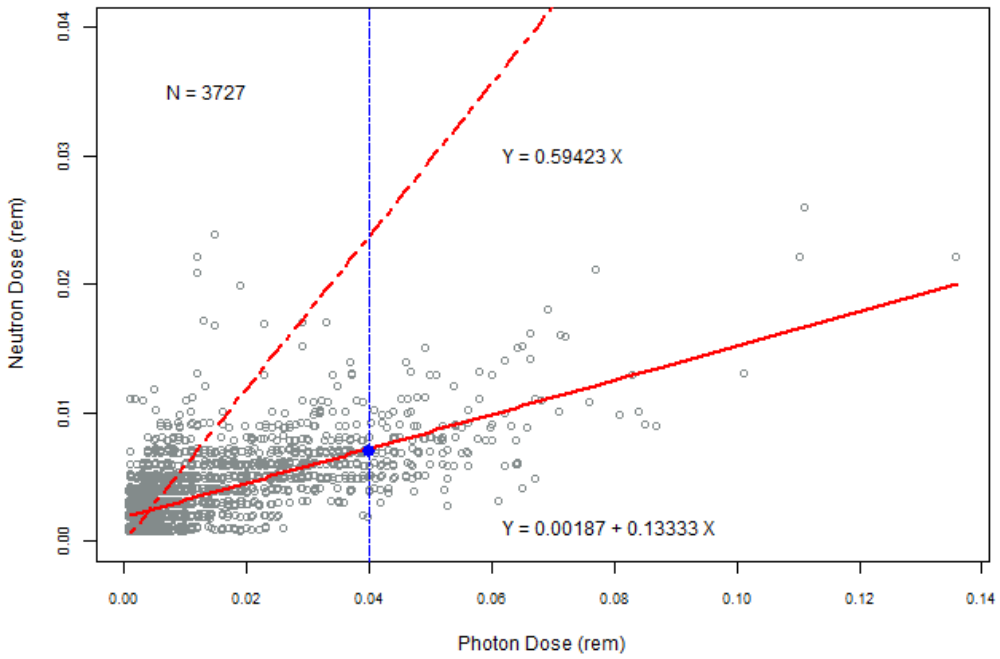

Figure 1. Plot of photon dose versus neutron dose at Portsmouth.

When the two variables (neutron and photon dose) are collapsed into one variable (the N:P ratio), information is lost, and this loss of information leads to a decrease in predictive accuracy. The information lost is essentially how the N:P ratio changes as a function of photon dose. Applying the geometric mean from the lognormal model to all levels of photon dose assumes that the ratio does not change as a function of photon dose, which Figure 1 shows is visibly wrong and can lead to less accurate predictions of neutron dose. This is why quantile regression is preferred over lognormal fits to N:P ratios. In situations where the dataset is small, quantile regression does not perform well. In those cases, lognormal fits to N:P ratios are used, as described in ORAUT-RPRT-0087.

There is the implication that quantile regression should not be used because it gives smaller doses than the N:P ratio method. Dose reconstruction is grounded on the best available science, and the QRA method is clearly more accurate, and therefore superior, when sufficient data are available. Analysis methods are not ranked by how much dose is delivered but by the strength of the science.

QRA is consistent with neutron dose assignment at other DOE sites where a neutron exposure is assumed but no dosimetry data exist. In many of these cases, a dose is assigned based on the photon dose received, which is what the QRA method accomplishes.